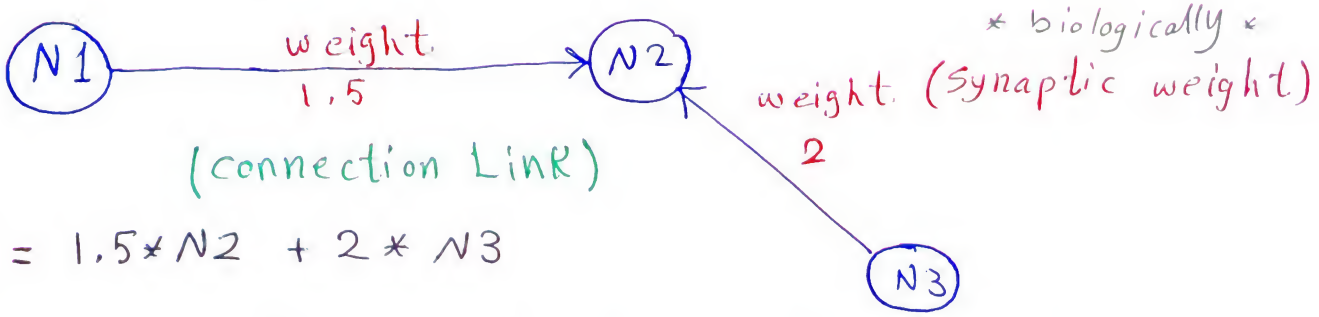
Neural

28/9/2016 الأربعاء د. محمود فتحي محاضرة [1]

- Human Brain is considered a metaphor (مثال)
- We try to emulate Biological Neural Networks. Although it is not perfect, it provide solution for many Application Problems
- Neuron :- The basic information processing Unit symbol : (N) or ○ [Artificial]

* Brain contain 10^{11} neurons

#write two paper of something like [Wonders of brain]



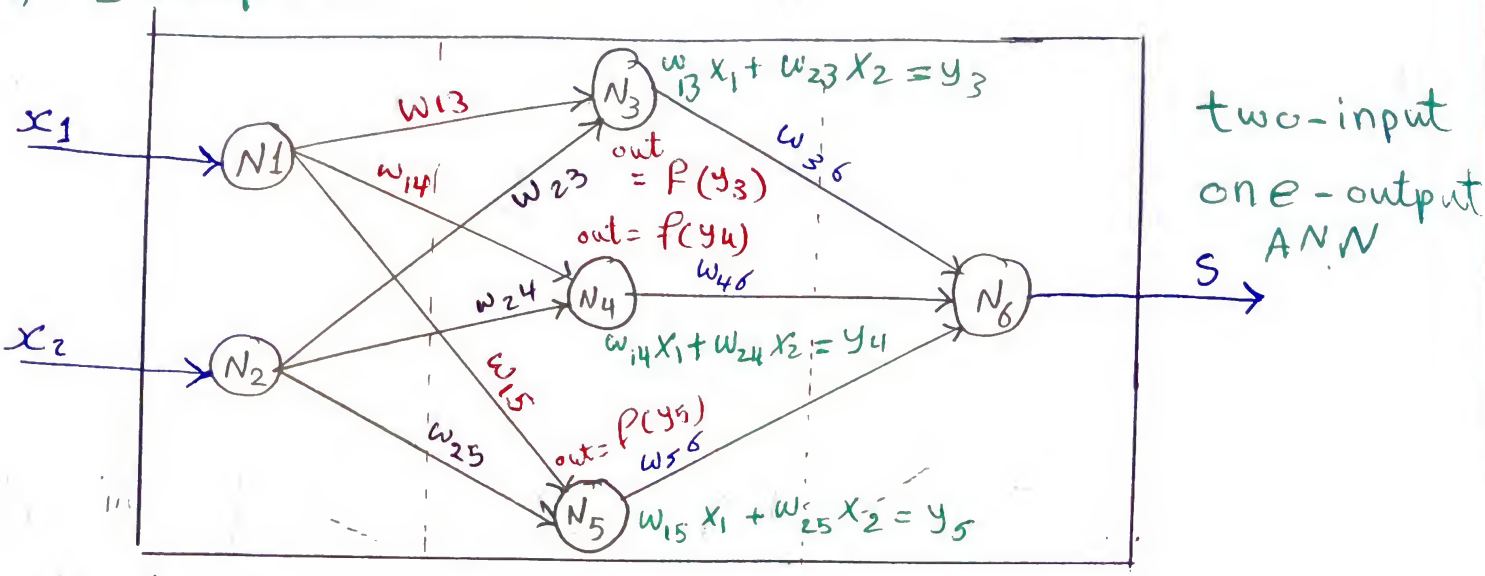
(connection Link)

$N1 = 1.5 * N2 + 2 * N3$

information go from neural to another through "connection link" with "weights"
"weights" can multiply or block information signals.

- ANN is divided to 3 Layers
  1. Input Layer (input neurons)
  2. Hidden Layer(s) (Hidden neurons)
  3. output Layer (output neurons)

Example :-



input layer hidden layer output layer

- Fully connected ANN: All neurons are connected to the adjacent neurons as shown in the example.
- Input layer neurons have no function, other neurons consist of "activation function" and "$\Sigma x \cdot w$"

for the example above:

"$w_{src\ dest}$"

$N_1 = x_1$, $N_2 = x_2$

$y_3 = w_{13} x_1 + w_{23} x_2$

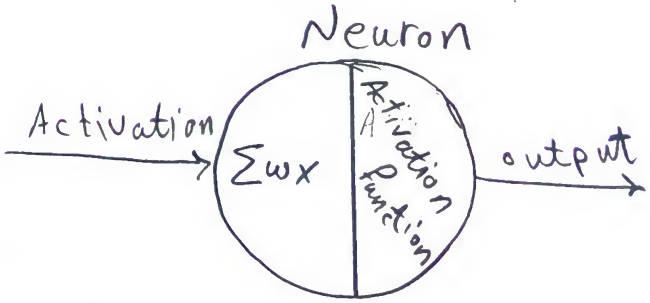
$y_4 = w_{14} x_1 + w_{24} x_2$

$y_5 = w_{15} x_1 + w_{25} x_2$

Not Final Formula

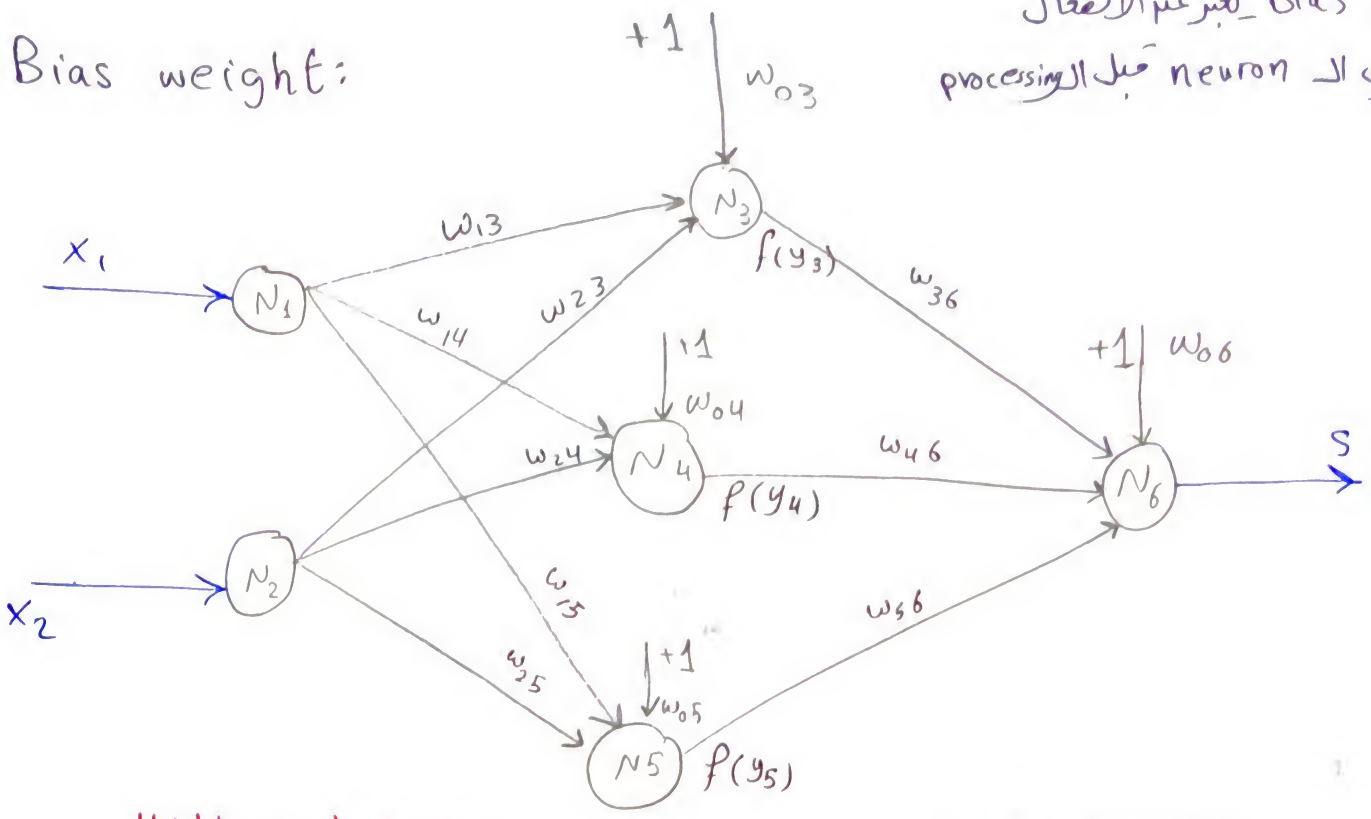
$y_6 = w_{36} f(y_3) + w_{46} f(y_4) + w_{56} f(y_5)$

$S = f(y_6)$



Bias weight:

الـ Bias يعبر عن الانفعال في الـ neuron قبل الـ processing



Hidden Layer

* Activation of neuron N_3

$$y_3 = w_{13}x_1 + w_{23}x_2 + w_{03}$$

* Activation of neuron N4

$$y_4 = w_{14}x_1 + w_{24}x_2 + w_{04}$$

* Activation of neuron N5

$$y_5 = w_{15}x_1 + w_{25}x_2 + w_{05}$$

output Layer

Activation of Neuron N_6

$$y_6 = w_{36}f(y_3) + w_{46}f(y_4) + w_{56}f(y_5) + w_{06}$$

$$S = f(y_6)$$

* ANN can be trained or Learn (Essential feature)
* by training or Learning we mean that the network design changes in every iteration until reaching the desired output

* Free Design Parametrs:-

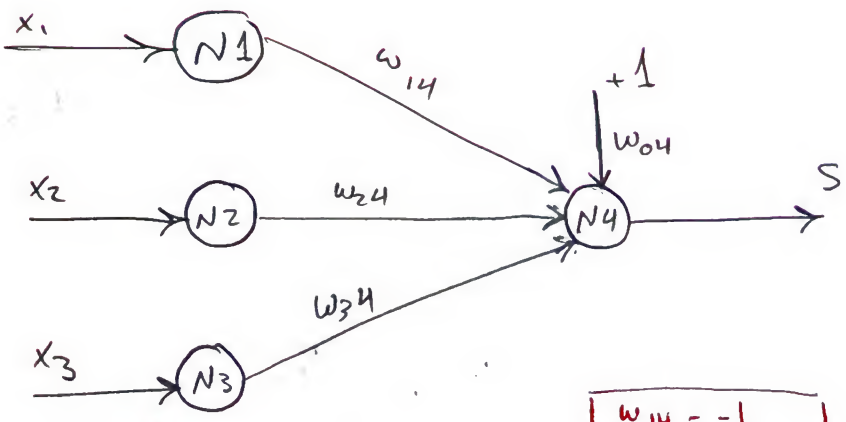
- "Synaptic Weights" are the design parameters.

  Modifying the weights changes the behaviour of the ANN [Design]

- changing the weights is based on some algorithms
- We keep changing the design parameters until we get our desired response

Example 1

ANN



given
$x_1 = -1$; $x_2 = -2$; $x_3 = 1$

$w_{14} = -1$
$w_{24} = 1.5$
$w_{34} = 2$
$w_{04} = -0.5$

Activation function : Binary threshold function

Find S.

Analysis: System exist and we get the properties

Design: properties exist and we get the system

Skip to Page "5" for activation functions

Solution in Page 5

Activation functions :-

① Binary threshold function

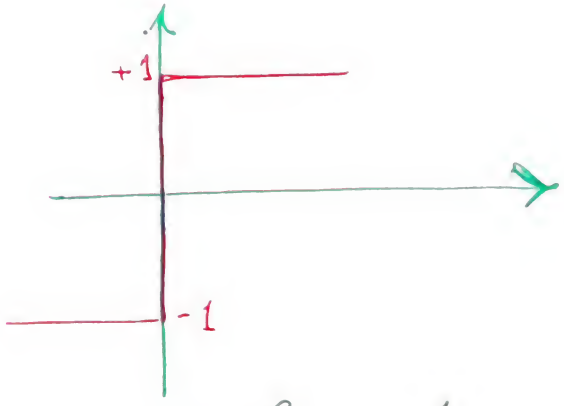
② Bipolar threshold function

Binary

$y < 0 \rightarrow f(y) = 0$

$y > 0 \rightarrow f(y) = 1$

Bipolar



$y < 0 \rightarrow f(y) = -1$

$y > 0 \rightarrow f(y) = 1$

Solution for "NOT" Example

Activation of output neuron $N4$

$$y_4 = x_1 w_{14} + x_2 w_{24} + x_3 w_{34} + w_{04}$$

$$= (-1)(-1) + (-2)(1.5) + (1)(2) + (-0.5)$$

$$= -0.5 < 0$$

output signal (Binary threshold)

$$S = 0$$

Example 2:

Repeat Example 1 for weights value

$w_{14} = 0.5 \quad w_{24} = -2 \quad w_{34} = -1.5 \quad w_{04} = -0.8$

Activation of output neuron N4

$$y_4 = x_1 w_{14} + x_2 w_{24} + x_3 w_{34} + w_{04}$$

$$= (-1)(0.5) + (-2)(-2) + (1)(-1) + (-0.8) = 1.2 > 0$$

$$\Rightarrow S = f(y_4) = 1$$

Example 3 :-

In Ex 1, Let $w_{14} = w_{24} = w_{34} = 0.5$, find the value of the bias weight w_{04} such that the activation y is zero

Solution :- Activation of the output neuron

$$y = x_1 w_{14} + x_2 w_{24} + x_3 w_{34} + w_{04}$$

$$= (-1)(0.5) + (-2)(0.5) + (1)(0.5) + w_{04}$$

$$= -1 + w_{04} = 0 \Rightarrow w_{04} = 1$$

Example 4 :-

repeat Ex 1 for bipolar threshold function

from Ex 1 we know

$$y_4 = -0.5$$

$$\Rightarrow S = -1$$

Example 5 :-

repeat Ex 1 for bipolar threshold signal on N4 (output) and have weights of Ex 2

from Ex 2 we know

$$y_4 = 1.2$$

$$\Rightarrow S = 1$$

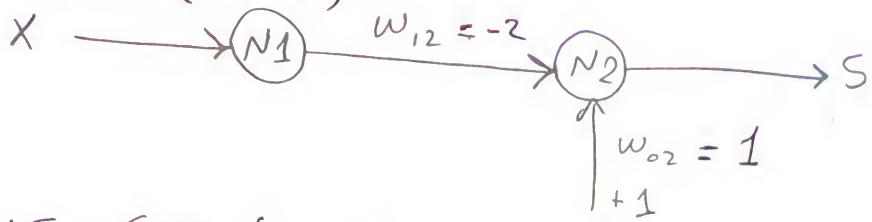
* يمكن تحقيق ANN عن طريق

① برامج Simulation (Computer Software)

② توصيل مجموعة من المكونات الإلكترونية التي تمثل الشبكة (Hardware)

Implementation of Logic circuits (gates)

- Example 6:- (NOT)



نستخدم دالة binary threshold signal output لأن الشبكة يمكنها تحقيق Logic NOT function عندما

$w_{12} = -2$, $w_{02} = 1$

Activation of output neuron N2,

$$y = x w_{12} + w_{02}$$

$$= -2x + 1$$

Solution

for $x = 0$ we have

$y = 1 > 0 \longrightarrow s = 1$

for $x = 1$, we have

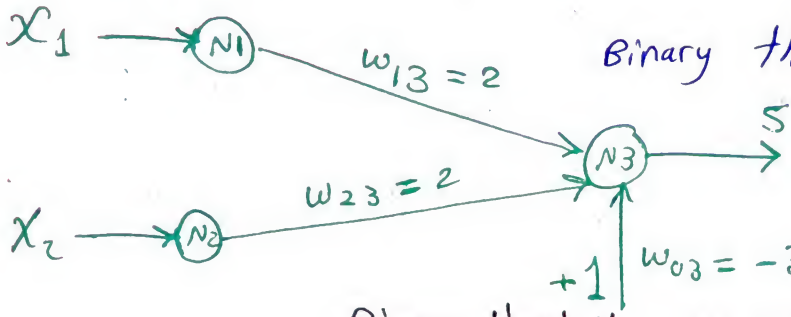
$y = -2 + 1 = -1 < 0 \longrightarrow s = 0$

طلع قيم أخرى لـ weights تكون أولا تحقق الـ inverter

x	y
0	1
1	0

"NOT" truth table

Example 7:- (AND)



- أثبت أن الشبكة تحقق Logic AND function و الـ output بكل Binary threshold
- أوجد قيم أوزان الـ weights لكل AND gate

* activation of output neuron N3

$$y = x_1 w_{13} + x_2 w_{23} + w_{03}$$
$$= 2x_1 + 2x_2 - 3.5$$

for $x_1 = 0$ and $x_2 = 0$

$y = -3.5 < 0 \longrightarrow$ **S = 0**

for $x_1 = 0$ and $x_2 = 1$

$y = -1.5 < 0 \longrightarrow$ S = 0

for $x_1 = 1$ and $x_2 = 0$

$y = -1.5 < 0 \longrightarrow$ S = 0

for $x_1 = 1$ and $x_2 = 1$

$y = 0.5 > 0 \longrightarrow$ S = 1

AND

x_1	x_2	
0	0	0
0	1	0
1	0	0
1	1	1

Example 8:

for the previous example, prove that ANN realize "OR" Logic function

weights: $w_{13} = 2$; $w_{23} = 2$, $w_{03} = -1.5$

Find other values for weight to realize "OR" gate

References :-

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② Simon Haykin : Neural Networks and Learning Machines, 3rd edition, 2009

③ Satish Kumar : Neural Networks : A class room Approach, 2004

④ Daniel Groupe : Principles of Artifical Neural Networks, second Edition, 2007

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⑥ S. Samarasinghe : Neural Networks for applied Sciences and Engineering, 2007